

Challenges Of Large-Scale Distributed Real-Time Embedded Systems

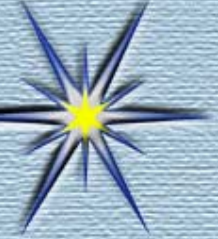
David Sharp

Technical Fellow

Phantom Works, Open System Architecture

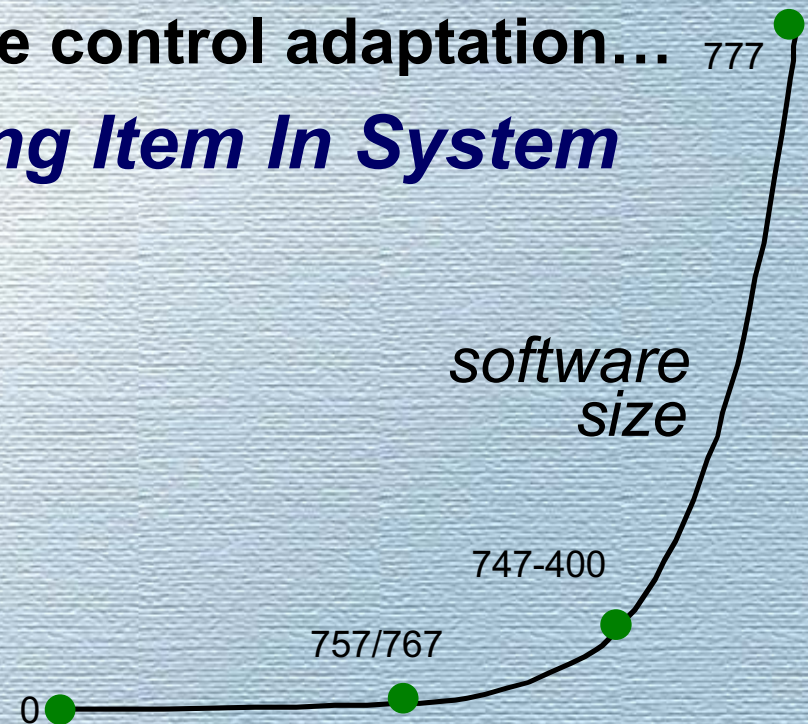
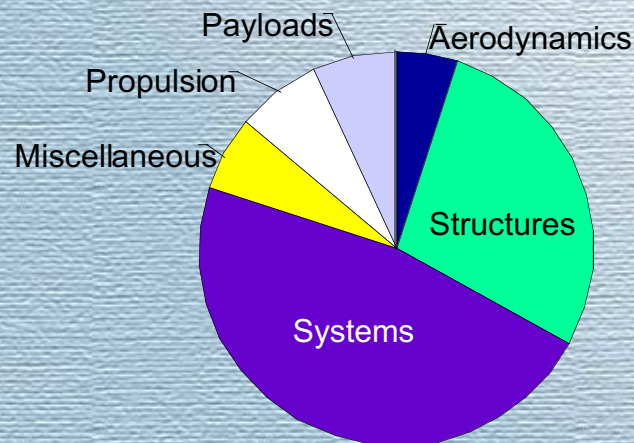
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1 December 2001



Problem Challenges

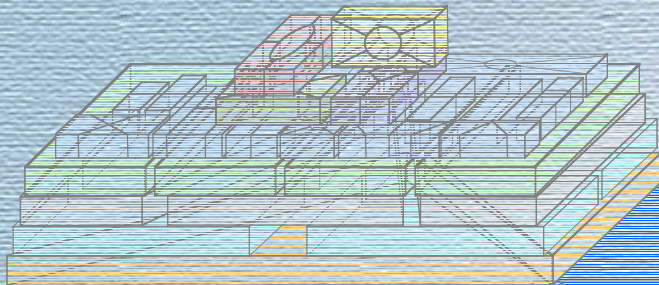
- ***Operational Complexity of Large-scale Embedded Systems Is Growing Exponentially***
 - New capabilities: networked autonomous UAVs...
 - Extended capabilities: online control adaptation...
- ***...And Represents A Pacing Item In System Cost and Schedule***



Current Leading Practices- Boeing Bold Stroke Initiative

Bold Stroke

Object-Oriented Reusable Application Framework

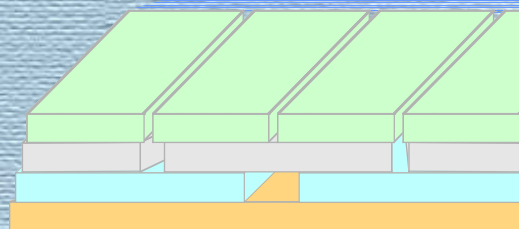


Architecture Specific Service Software

- Configurable to variable hardware configurations
- Supportive of reusable applications

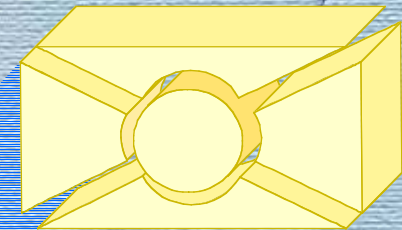
- COTS-based real-time middleware services

Standard Service Software



Commercial and Standards-Based Platform

Product Line Component Model



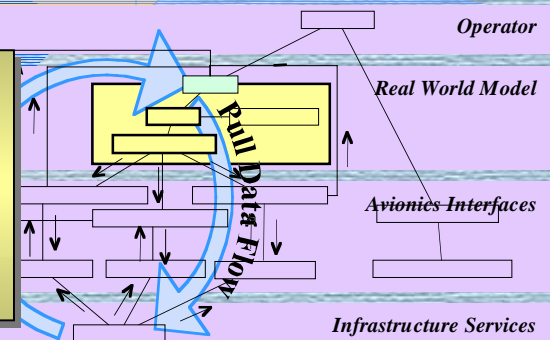
Single Component Development Policies

- Configurable for Product Specific Functionality and Execution Environment

- Configurable for Product Specific Component Selection and Distribution Environment

Component Integration Policies

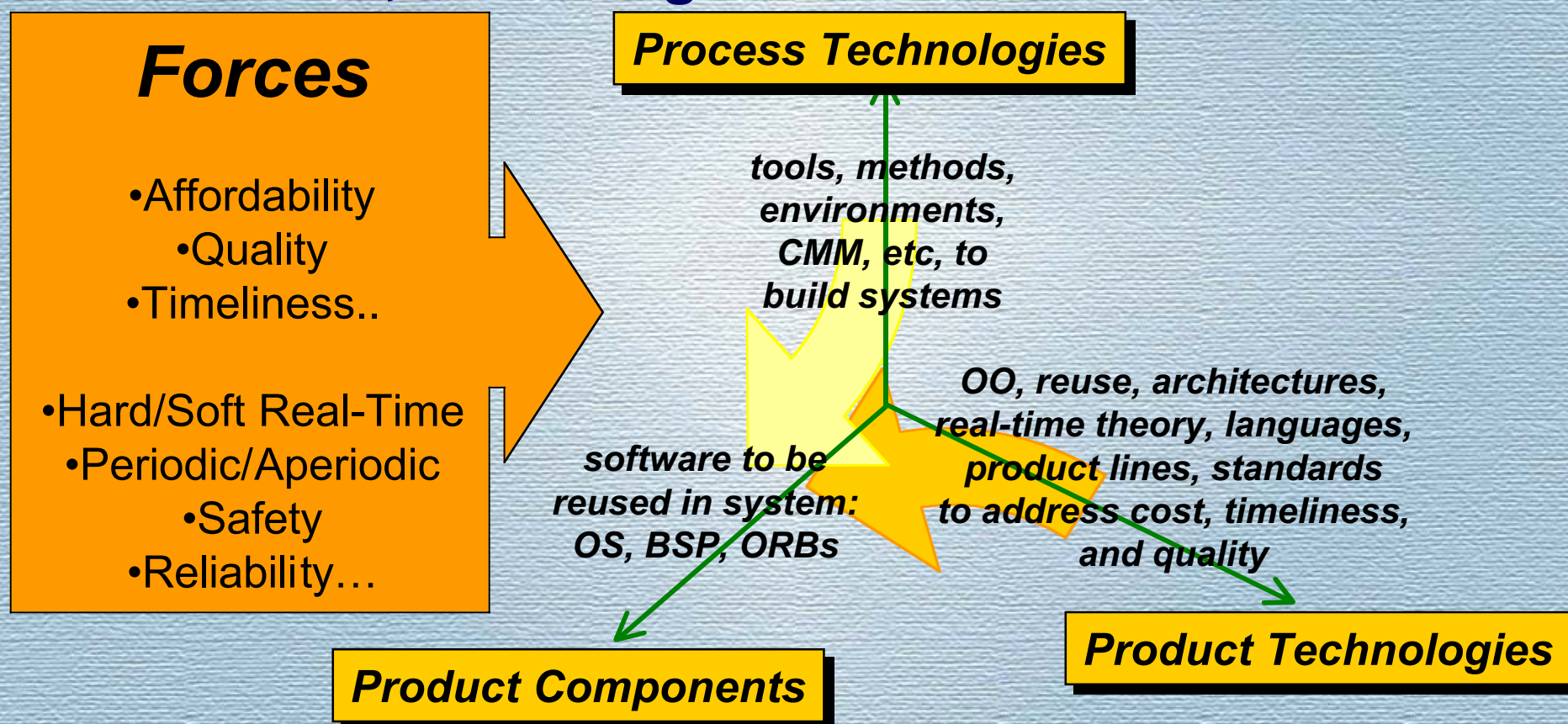
*Helping To Bridge the
Gap Between Research,
COTS, and DoD
Practice*



Component Integration Model

Technology Challenges

- *Multiple Dimensions Must Be Addressed, Balanced, and Integrated*



Resource Management



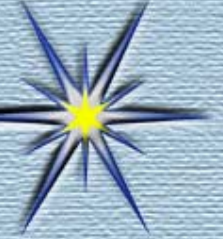
- *Supporting resource management of multiple cross-cutting properties*
 - Timeliness, quality, security, power, reliability, etc
- *...across increasing scope of resources (increasing numbers/types)*
 - CPUs, memory subsystems, networks, vehicles, etc
- *...adaptively using reflective (“own system”) information*



Specific Challenges

Bold Stroke

Verifiability and Certifiability



component development

component configuration

component integration

system initialization

discrete mode transitions

continuous adaptation

design time

run time

time at which
operation is
predictable

current research leverages

**current
practice
assumes**

>\$1B
to
certify

**Need To Extend Both Verification Timeline and
Locality To Leverage Emerging Technologies**

System Integrator's Technology Challenge

Bold Stroke



Combine Multiple Cross-Cutting Technologies for Unprecedented Developmental and Operational Capabilities

- ***Heterogeneous Systems: Unique Challenge of Integrating Coupled Technologies***
 - Diverse safety criticalities
 - Soft and hard real-time deadlines
 - Discrete and continuous time computations
 - Multiple security levels
 - New and legacy architectural frameworks
 - Within and between systems

...Simultaneously!